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AC NO: AC 121-13
DATE: 10/14/69

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: SELF-CONTAINED NAVIGATION SYSTEMS (LONG RANGE)

1. PURPOSE. This Advisory Circular states an acceptable means, not the only means, of compliance with the referenced Sections of the FAR as they apply to persons operating under Parts 121 or 123 who desire approval of Doppler RADAR navigation systems or Inertial Navigation Systems (INS) for use in their operations.

2. REFERENCES. Federal Aviation Regulations 121.355, 121.389, 121.411, 121.412, 121.413, 121.415, 121.417, 121.418, and AC 25-4.

3. CANCELLATION. Advisory Circulars 121-10 and 121-11 dated 3/23/67 are canceled.

4. INFORMATION. Doppler RADAR and Inertial Navigation Systems (INS) are self-contained navigation systems which are not continuously dependent on information derived from ground-based or exterior aids. However, exterior aids, such as LORAN and CONSOL or Celestial Navigation are required for periodic updating of Doppler. Updating of Inertial is permissible if the operator so desires, provided the updating technique is demonstrated and approved, and accounted for in the determination of the absolute accuracy of the system. Requests for approval of INS as the sole means of navigation, or in combination with other self-contained aids, may be made. Adequate terminal ground-based radio navigational aids are necessary to support either INS or Doppler approvals. Under the provisions of FAR Sections 121.355 and 121.389, cockpit navigation over international routes previously requiring a navigator may be approved using Doppler RADAR or Inertial Navigation Systems.

5. GENERAL. The operator desiring approval for use of Doppler RADAR or Inertial Navigation Systems should contact the local Air Carrier District Office or International Field Office for advice in the preparation of an initial written request for FAA evaluation of its proposal. The information needed is described in item 6 of this

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circular. Thirty days should be allowed for review and evaluation of the initial request. Subsequent to approval of the initial request, the operator may submit an application for approval of operations specifications, en route flight procedures following the guidelines established in item 7 of this circular.

6. INITIAL REQUEST FOR EVALUATION. The initial request for evaluation of an operator proposal for use of Doppler RADAR or Inertial Navigation Systems should contain information concerning the following:

   a. Experience. Prior to presenting its initial request, an operator should have accumulated sufficient experience with the equipment to establish a history of the accuracy and reliability of the system it proposes to use. The applicant may include previous or related operational experience of other operators, and operational experience gained during type certification of the aircraft. Once a particular system has received an equipment approval, evaluation and approval in subsequent similar installations may be adjusted or omitted to avoid duplication of the lengthy accuracy and reliability data gathering process involved in the issuance of the original approval. A comprehensive summary of this experience should be provided to show competency in the operation and maintenance of the equipment and feasibility of the proposed operation.

   b. Training Program. The operator should outline the training program he plans to set up to comply with Sections 121.411, 121.412, 121.413, 121.415, 121.417, and 121.418. Under these rules, the training program for Doppler or Inertial Navigation Systems is acceptable if:

      (1) It encompasses all phases of the operation and the responsibilities of flight crewmembers, dispatchers and maintenance personnel.

      (2) Its technical content, for pilots, covers:

         (a) Theory and procedures, limitations, detection of malfunctions, pre-flight and in-flight testing, cross-checking methods, etc., relating to the operation;

         (b) The use of computers, an explanation of all systems, compass limitations at high latitudes, a review of navigation, flight planning and applicable meteorology;

         (c) The methods for updating by means of reliable fixes; and,

         (d) The actual plotting of fixes.

(3) Its recurrent training program includes training and line checks using the self-contained navigation system.

* (4) Each pilot assigned as an operating crewmember completes as many trips over a route or area (either in actual operation, or in a simulator, or training device, approved for conducting the required pilot training and qualifications in the use of these systems), under the supervision of a check airman, as may be necessary to:

*

(a) Ensure his qualification in the system; and,

(b) Enable certification of his proficiency in the system, as required by Section 121.401.

(5) Training of flight crewmembers is acceptable during evaluation flights.

c. Maintenance Program. The applicant should provide an outline of the training to be given maintenance personnel on the new equipment, proposed intervals for inspection and overhaul, test and inspection procedures as specified in Subpart L of FAR 121, the stationing of spare parts and test equipment, and revisions to the maintenance manual.

d. Equipment Installation.

(1) The installation should include a navigation computer for each Doppler RADAR or Inertial Navigation System required. Cockpit arrangement should be such as to afford easy viewing and manipulation of necessary controls consistent with priority of existing equipment.

(2) Dual Inertial Navigation Systems (including navigational computers and reference units) are acceptable under FAR 121.355 when installed in accordance with the criteria set forth in AC 25-4. Dual Doppler RADAR equipment (including dual antennas or a combined antenna designed for dual operation) are also acceptable. For Doppler, a single operating transmitter with a standby capable of operation is acceptable in lieu of two operating transmitters.

(3) When dual Doppler is installed, it will be permissible to utilize single heading source information to both equipments, providing a compass comparator system is installed, and operational procedures call for frequent cross-checks of all compass heading indicators by crewmembers.

(4) Currently, other navigational aids are considered necessary to update the Doppler RADAR, such as LORAN, CONSOL, DME, VOR or ADF. Such facilities should be available for the proposed route and the cockpit arranged so as to afford easy manipulation of the necessary controls. If a single LORAN is used for this purpose, it should be accessible to both pilots at their duty stations.

(5) Cockpit arrangements should provide for adequate lighting, suitable charts, plotting, necessary forms and related equipment.

e. Operations Manual. Revisions to the Operations Manual should outline all normal and emergency procedures relative to use of the proposed system. Detailed methods for continuing the navigational function with partial or complete equipment failures, and methods for determining the most accurate system when an unusually large divergence occurs should be included.

f. Minimum Equipment List (MEL). A proposal for revising the operator's approved MEL should be included. Items which are not required to be operative for dispatch, including existing items which can affect the operation of the proposed equipment, should be fully justified on the basis of an acceptable level of safety. Any exceptions should be as specifically itemized in the "Remarks" column of the minimum * equipment list for the aircraft concerned. In any event, the operator's MEL should not authorize items to be inoperative that are not authorized by the Master MEL. If the proposal submitted by the operator should include such items, they should be referred to the proper FOEB with complete justification and recommendations for necessary action. *

g. Routes or Areas.

(1) Each route or area being proposed for self-contained cockpit navigation should be analyzed with respect to length, magnetic compass reliability, availability of en route aids, and adequacy of gateway and terminal radio facilities to support the system used. Every available facility, including radar, should be used to ensure navigational accuracy, particularly where a route is proximate to restricted airspace.

(2) Routes based on heading information from slaved magnetic compasses will not be authorized for Doppler navigation in areas having a weak or unreliable earth magnetic field. If free-gyro operation is proposed, detailed procedures for transition to, and use of this form of navigation, should be applied.

(3) The use of INS into airports at latitudes above 76° 30' should be covered by procedures for high latitude platform realignment.

(4) Precise coordinates accurate to within one minute of arc should be established for a designated geographic fixed position on each airport to be used for the establishment of alignment and insertion of present position data in the aircraft's INS prior to takeoff.

h. Demonstration of Operational Ability. The operator should provide a schedule of flights which shows his ability to use cockpit navigation in his operations, instead of a navigator or a previously approved specialized means of navigation. During these flights, the pilots should navigate the aircraft using the self-contained system and their navigational duties should not encroach significantly on other required duties. The pilots should be relieved of any workload associated with any previously approved specialized means of navigation. This should be done by adding a navigator or other navigationally qualified flight crewmember as appropriate. This additional flight crewmember should track the flight independent of the Doppler or Inertial System, and give the information obtained to the pilot-in-command. The pilot-in-command decides if changes in course are necessary to remain within allowable navigational limits. Self-contained systems should not be used in Parts 121 or 123 operations until the agency approves amended operations specifications (see paragraph 7.a.). Systems installed and approved during type certification of the aircraft may secure operational approval during the aircraft proving flights.

i. Equipment Accuracy and Reliability.

(1) Self-contained navigation units should be maintained within the accuracies appropriate for the specific air route structures in which they are to be used and the accuracy tolerances specified in the operator's maintenance manual. Specifically, the accuracy appropriate for use over the North Atlantic has been considered as a maximum error of $\pm$ 20 nautical miles cross-track and $\pm$ 25 miles along-track for 95% of the flights completed.

(2) Compass heading information to the Doppler RADAR should be maintained to an accuracy of $\pm$ 1.0 degree and total system deviation should not exceed 2 degrees.

j. FAA evaluation should ensure:

(1) Adequacy of operational procedures.

(2) Operational accuracy and reliability of equipment and feasibility of the system over proposed routes or areas.

(3) Availability of terminal, gateway, area and en route ground-based aids to support the self-contained system.

(4) Acceptability of cockpit workload.

(5) Adequacy of flight crew qualifications.

(6) Adequacy of maintenance training and placement of spare parts.

k. FAA observations:

(1) Air carrier operations inspectors will observe sufficient flight or simulator qualification checks given to the first flight crews qualified during an initial evaluation program to ensure valid appraisal of the items listed in paragraph 6.j.

(2) Inspectors will observe enough flight checks after operational approval to ensure that the operator maintains the overall quality of his maintenance and training programs.

(3) When the operator applies for additional routes or areas, inspectors will observe enough flights to ensure the adequacy of the terminal, gateway, area and en route facilities to support the self-contained system.

(4) Carriers will be expected to make available to the agency, records of accuracy and reliability for the systems being evaluated for a reasonable period before and after the operational evaluation.

7.. REQUEST FOR APPROVAL.

a. The operator may forward a request for approval of its proposal following FAA observation of a representative number of satisfactory pilot qualification checks and resolution of all items arising during the initial evaluation program. Final FAA approval is indicated by approval of amended operations specifications, en route flight procedures, defining the new operations. Approval is limited to those routes or areas over which the adequacy of the equipment and the feasibility of cockpit navigation has been demonstrated.

b. Proposed operations specifications authorizing cockpit navigation should contain the following:

(1) Specific points (gateways) fixed by an acceptable ground-based navigational aid where use of Doppler RADAR navigation will commence and terminate.

(2) Latitude limits for the system used. Type heading reference authorized for Doppler navigation, i.e., Slaved Magnetic Compass or Free Gyro.

(3) Requirement that pilots be qualified in the navigational system.

(4) Specific navigation equipment that may be inoperative for dispatch.

8. COORDINATION WITH WASHINGTON OFFICE.

a. The appropriate Air Carrier District Office (ACDO) or International Field Office (IFO) advises FS-400:

(1) When an application for evaluation is received;

(2) When any problem areas exist; and,

(3) Concerning the status of the program as it progresses.

b. Before approving the use of Doppler or Inertial navigation over any route or area, the ACDO or IFO coordinates its recommendations with FS-400.

actingDirector
Flight Standards Service

FEDERAL AVIATION AGENCY

OPERATIONS SPECIFICATIONS - EN ROUTE FLIGHT PROCEDURES

Form Approved
Budget Bureau No. 04-R083.1

ROUTE OR ROUTE SEGMENT	VIA	OPERATION AUTHORIZED				TYPE OF AIRCRAFT AUTHORIZED		SPECIAL REQUIREMENTS				
		DAY		NIGHT								
		VFR	IFR	VFR	IFR	B-707		MOCA	MEA	MAA	OTHER	TYPE NAVIGATION[1]
"Western Gateway Goose Bay NDB/VOR, Gander NDB/VOR, Nantucket Consol VOR, Torbay NDB, Keflavik NDB/VOR (8), Santa Maria NDB/VOR (8), Saglek NDB, St. Anthony NDB, Sydney VOR/NDB, Boston VOR/NDB "Eastern Gateway Keflavik NIB/VOR (8), Stornaway NDB, Skipness NDB/VOR, Bushmills Consol, Belfast NDB, Shannon LFR/VOR, Cork VOR, Jersey NDB, Dublin VOR/NDB, Ploneis Consol, Gognac NDB/VOR, Lugo Consol, Lisbon NDB/VOR, Santa Maria NDB/VOR (8), St. Nawgan VOR/NDB, Bilbao NDB, Madrid/Del Ray NDB via Santiago NDB, Lajes VOR/NDB, Strumble VOR/NDB, Nantes VOR, New Galloway NDB	All routes over North Atlantic between Eastern and Western Gateways with the limits of operation between latitude 65°N and latitude 35°N	NA	LX	NA	LX	X	NOTES: "Cockpit navigation authorized with the following equipment operating satisfactorily, at dispatch: 1. Dual Doppler and Computer Systems (Except one 10-mile alert light may be inoperative, and one offset indicator may be inoperative, provided the associated offset miles indicator is operative.) 2. Dual Polar Path Compasses 3. ADF 4. VOR 5. One Loran receiver operable from both of the two pilot stations. (Except Eastbound out of Santa Maria.) 6. Both pilots will be Doppler qualified in accordance with approved training programs, except that when navigation is being performed under the supervision of an approved Doppler-qualified check pilot, the pilots performing such supervised navigation need only have satisfactorily completed the approved Doppler ground school curriculum. * 7. Operation of overwater portion of transatlantic flights is authorized up to and including 42,000 feet. 8. Following route segments approved without an alternate: (a) Eastbound only-U.S. & Canada terminals to Keflavik or Santa Maria. (b) Westbound only-European terminals to Keflavik or Santa Maria.					Doppler

EFFECTIVE DATE	NAME OF AIR CARRIER
	XYZ AIRLINES, INC.

[1] Where a navigator or special cockpit navigation and equipment is required, so specify; ie Navigator, Cockpit (Doppler - Loran), (Inertial).

FAA Form 8400-1 (8-66) FORMERLY FAA FORM 514A

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

OPERATIONS SPECIFICATIONS - EN ROUTE FLIGHT PROCEDURES

Form Approved
Budget Bureau No. 04-R083.1

ROUTE OR ROUTE SEGMENT	VIA	OPERATION AUTHORIZED				TYPE OF AIRCRAFT AUTHORIZED				SPECIAL REQUIREMENTS				
		DAY		NIGHT		DC-8				MOCA	MEA	MAA	OTHER	TYPE NAVIGATION[1]
		VFR	IFR	VFR	IFR	B-707								
						etc.								
Approved routes and oceanic areas will be listed here. Example:						Notes: Cockpit (INS) navigation authorized with the following equipment operating satisfactorily at dispatch:								Inertial
Frobisher to Churchill to Edmonton	Direct	NA	X	NA	X	1. Dual INS and Computer Systems (Items of equipment that may be inoperative will be included in the operators approved MEL and shown on this operations specification (below)).								
or														
North Atlantic Ocean	All routes over North Atlantic between Eastern and Western Gateways.	NA	X	NA	X	2. Both pilots will be Inertial qualified in accordance with approved training programs, except that when navigation is being performed under the supervision of an approved Inertial qualified check pilot, the pilots performing such supervised navigation need only have satisfactorily completed the approved Inertial ground school curriculum.								
						3. Operation of overwater portion of transatlantic flight is authorized up to and including 42,000 feet.								
						4. Ground alignment limited to 76°, 30' N&S latitude which is the highest latitude at which satisfactory ground alignment has been demonstrated.								

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FAA Form 8400-1 (3-68)